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ABSTRACT

This paper provides a literature review on the use of assistive technology with students who have disabilities, especially students with learning disabilities. It stresses requirements that assistive technology be included in Individualized Education Programs when necessary. Topics examined in the review include: (1) the use of technology to facilitate inclusion; (2) how assistive technology aids individuals with sensory or motor disabilities; (3) provisions of the Technology-Related Assistance of Individuals with Disabilities Act and its 1994 amendments; (4) the eleven activities mandated by this law; (5) strategies used by states to implement the law; (6) court litigation related to assistive technology and students with disabilities; (7) principles underlying court decisions in this area; (8) ethical issues; (9) access to technology; and (10) technology as a means to surmount a variety of barriers, including print barriers, communication barriers, and learning barriers. A summarizing discussion focuses on the value of assistive technology to enhance students' strengths, minimize their deficiencies, and enable their success within the existing classroom curriculum and the importance of training teachers to reap such benefits for their students. (Contains 52 references.) (DB)

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# Assistive Technology and Learning Disabilities

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A Research Paper Submitted to the Faculty of the Department of Special Education at Chicago State University in Partial Fulfillment of the Degree of Master of Science

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## APPROVAL PAGE

**This paper was reviewed and approved by Dr. Barry W. Birnbaum, Department of Special Education, Chicago State University.**

**Barry W. Birnbaum, Ed. D.** — **Date** 8/4/99

Abstract

School districts are required to provide assistive technology (AT) devices or services to individual disabled students, at no cost, if a student's individualized education plan (IEP) team determines that the student needs AT devices or services in order to receive a free appropriate public education (FAPE) in the least restrictive environment (LRE). AT is not aimed at curing, fixing, or remediating disabilities; rather, it is used as a strategy to compensate for, or circumvent, a disability. There is a concern that some educators have not had adequate training in the use of AT and also a question as to when AT moves from being necessary to being a luxury. The proper use of technology in the classroom has allowed disabled students to participate effectively in the learning process and that teachers need the time and opportunity to learn what the technology can do, how to operate it, and when and how to implement and integrate it into their teaching.

## Introduction

In the last decade, technological advances have provided new opportunities for persons with learning disabilities (LD) to compensate for deficient requisite skills and access information that was formerly inaccessible. Assistive Technology (AT) devices and services allow users to develop compensatory skills so that disabilities in a particular area, such as reading and writing, can be bypassed and material becomes accessible that could not have been accessed previously.

As defined by the Technology-Related Assistance for Individuals with disabilities Act Amendments of 1994 (known as the Tech Act), assistive technology is "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities," and services as "any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology service." "Devices" encompass low technology (e.g., reachers, pencil grips, zipper pulls) and high technology (e.g., alternate computer keyboards, speech synthesizers, scanners), "services" include assessment, interagency coordination efforts, and training. These devices or services can be provided as special education, related services, or supplementary aids and services, or if the IEP team determines that AT devices or services be individually tailored to address the individual student's unique educational needs.

When determining which AT devices and services are appropriate for students, the IEP team must consider the wide array of assistive devices available; ranging from low technology to extremely advanced systems. The tendency is to select either the least expensive option or the one that educators already know how to operate, with little regard for the unique needs of the student. If teachers do not receive adequate training in the use of AT, it is possible that when determining the need for AT that it could be left out of the IEP do to the lack of training. As more students in LD and general education settings are identified as needing AT devices and services, teacher preparation programs in LD must explore ways to structure curricula, methodologies, and practica to better prepare teachers to work effectively with students who use AT devices.

## Review of Literature

Assistive technology (AT) has historically been viewed as beneficial to individuals with physical and sensory impairments. Wise and Olson (1994) found that in recent years there has been an increased focus on technology for people with learning disabilities and other cognitive disabilities. Opportunities in education, employment, and independent living have dramatically changed the lives of these individuals. AT can help teachers and special needs students overcome barriers to learning; also, they are great motivators for children who are developmentally delayed or learning disabled. "In addition, both private businesses and public institutions are required to make accommodations to their facilities for disabled persons and to remove any barriers to their employment. The combination of these forces have provided both the funding and the incentive needed to initiate innovations in adaptive technology," says Michael Milone. Milone (1997) says,

> technology adaptations for students with special needs span a huge range, from specialized controlling devices for quadriplegic students who have almost no mobility to educational software for which the publisher has provided guidelines for applications with special needs students. It's a pretty safe bet that if you have a student with special needs, there are software and hardware available to meet his or her needs. (p. 44)

The movement toward inclusion has been supported by the development of a wide range of technology, such as computers, telecommunications, and assistive devices, to help disabled students function in regular classrooms. Despite the promise that technology offers and the innovations in many individual classrooms, few schools or districts have

included significant numbers of students with special needs over their whole school career. Students need to participate year after year in customized educational experiences. Teaching and learning in one grade, including the use of technology, should build a foundation for the next. Few school districts have been able to create such pathways of learning (Moeller & Jeffers, 1995).

Those with sensory or motor disabilities can exercise some control over their environment with computers. Computers provide privacy, patience, and practice for students with LD. In addition to school and the workplace, there are a number of technologies that can help individuals with learning disabilities to cope with the demands of everyday life. Devices such as handheld calculators are used by much of the general public. To circumvent reading problems, listening to books on tape is very popular. Many new books are published in both print and audio formats, also, books are available on computer disks. These disks do not typically offer speech output, however, they do allow the reader to change the appearance of the text, search for specific topics, and make marginal notes. Reading machines designed for individuals who are blind help persons with severe reading problems by allowing auditory access to any type of printed material. AT can assist in the area of writing, many persons use handheld spelling devices for assistance with handwritten documents. Some of these devices have features including speech, dictionaries, and thesauruses in addition to spell checking. Voice mail has the capacity to eliminate many reading and writing problems associated with routine correspondence. A person can listen to a voice mail message and reply by phone instead of reading and writing a response (Lewis, 1998).

Technology can also assist with memory and organizational tasks. Telephone numbers can be programmed avoiding the necessity of remembering them. Electronic organizers are convenient for storing names, addresses, phone numbers, important dates, and personal memoranda for ready access. Calendar and time management programs are available for computers and for personal digital assistants.

A slogan used by International Business Machines (IBM;1991 as cited in Bryant & Seay, 1998) says it best, "For most people, technology makes things easier. For persons with disabilities, technology makes things possible" (p.2). Research examining the efficacy of technology for individuals with LD has reinforced this assertion (Raskind & Higgins, 1995b). Congress acknowledged AT's potential for assisting persons with disabilities to access the "American dream" when it passed into law in 1988 the Technology-Related Assistance of Individuals with Disabilities Act better known as the Tech Act. The overall purpose of the Tech Act was to provide financial assistance to states to help them develop consumer-responsive, cross-age, and cross-disability programs of technology-related assistance (Rehabilitation Engineering and Assistive Technology Society of North America, 1992). The passage of the Tech in 1988 reflected Congress'sense that the [Tech] Act promotes values inherent in the ADA.... By stating that disability is a natural part of the human experience and in no way diminishes the right of individuals with disabilities to live independently, enjoy self-determination, make choices, contribute to society, pursue meaningful careers, and enjoy full inclusion and integration in the economic, political, social, cultural, and educational mainstream of American society, the Act incorporates one of the fundamental concepts of the ADA—

that individuals with disabilities are able to pursue the "American dream." (House of Representatives Report 103-208, 1993, p.6)

In 1988 Congress allocated financial resources to states to establish statewide projects that would be responsible for improving each state's AT service delivery system, however, there were systemic obstacles that impeded the timely acquisition of AT services and devices. For this reason, the Tech Act was revised in 1994, and President Clinton signed the amendments into law in March 1994. According to Bryant and Seay (1998) The Tech Act contains five titles that provide the framework for developing a nationwide system for consumers to access when needing assistive technology devices and services. Title I provides grants to states for developing and implementing statewide assistive technology programs that are consumer responsive. In 1995 all states received funding.

Title II provides for the development of a national classification system to obtain data on assistive technology devices and services across public programs and information and referral networks. Funds were appropriated during the initial years of the grant for Title II projects, however, no funds have been appropriated since 1991, which limits the title's effectiveness. Title III is intended to stimulate the development of alternative funding mechanisms by supporting such services as low-interest loans and recycling programs, however, to date no funds have been appropriated for Title III, making its presence in the Tech Act questionable. Title IV provides information pertaining to amendments in the Individuals with Disabilities Education Act, the Rehabilitation Act of 1973, Administrative Requirements under the Head Start Act, and what are called Technical and Conforming Amendments, which are simply additional edits of the

Rehabilitation Act of 1973. Title V provided a starting date (October 1, 1994) for the Tech Act Amendments. According to Golinker (1994 as cited in Bryant and Seay, 1998)), when Congress passed P.L.103-218, the Technology-Related Assistance Act Amendments of 1994, it focused the purposes of the Tech Act on systems change and advocacy. As a result, the goals of the act read as follows:

(1) increase the availability of, funding for, access to, and provision of assistive technology devices and assistive technology services;

(2) increase the active involvement of individuals with disabilities and their family members, guardians, advocates, and authorized representatives, in the planning, development, implementation, and evaluation of such a program;

(3) increase the involvement of individuals with disabilities and, if appropriate, their family members, guardians, advocates, and authorized representative, in decisions related to the provision of assistive technology devices and assistive technology services;

(4) increase the provision of outreach to underrepresented populations and rural populations, to enable the two populations to enjoy the benefits of programs carried out to accomplish purposes decribed in this paragraph to the same extent as other populations;

(5) increase and promote cooperation among State agencies, and between State agencies and private entities, that are involved in carrying out activities under this title, particularly providing assistive technology

devices and assistive technology services, that accomplish a purpose described in another subparagraph of this paragraph;

(6) (a) increase the awareness of laws, regulations, policies, practices, procedures, and organizational structures, that impede the availability or provision of assistive technology devices and assistive technology services; and

(b) Facilitate the changes of laws, regulations, policies, practices, procedures, and organizational structures, that impede the availability or provision of assistive technology devices and assistive technology services;

(7) increase the probability that individuals with disabilities of all ages will, to the extent appropriate, be able to secure and maintain possession of assistive technology devices as such individuals make the transition between services offered by human service agencies or between settings of daily living;

(8) enhance the skills and competencies of individuals involved in providing assistive technology devices and assistive technology services;

(9) increase awareness and knowledge of the efficacy of assistive technology devices and assistive technology services among—

(a) individuals with disabilities and their family members, guardians, advocates, and authorized representatives;

(b) individuals who work for public agencies, or for private entities (including insurers), that have contact with individuals with disabilities;

(c) educators and related services personnel;

(d) technology experts (including engineers);

(e) employers; and

(f) other appropriate individuals;

(10) increase the capacity of public agencies and private entities to provide and pay for assistive technology devices and assistive technology services on a statewide basis for individuals of all ages; and

(11) increase the awareness of the needs of individuals with disabilities for assistive technology devices and assistive technology services. (p.4)

Golinker (1994) noted, (as cited in Bryant and Seay, 1998) when commenting on the change in focus, "the states are no longer free to pursue any or all of the goals stated in the Act.... Achieving the goals is a mandated activity" (p.8). There are six activities in the legislature that provide benchmarks used to evaluate each states Tech Act project's effectiveness in the areas of policy analysis, funding, interagency collaboration, consumer empowerment, and protection and advocacy. The first activity states that Tech Act project members are to be policy analysts. Each state project will undertake initiatives that will provide for

the development, implementation, and monitoring of State, regional, and local laws, regulations, policies, practices, procedures, and organizational structures, that will improve access to, provision of, funding for, and timely acquisition and

> delivery of, assistive technology devices and assistive technology services. [29 U.S.C 2212,(B) i]

Most states hire consultants or employ a policy analyst to examine local, state, and national laws and policies to identify specific barriers that inhibit the timely acquisition and use of AT devices and services. According to Bryant and Seay (1998) an example of effective policy analysis would be the discovery that a particular school or school district was in violation of free, appropriate public education (FAPE) guidelines because (a) it refuses to allow for an AT evaluation that has been requested by the IEP committee, (b) it refuses to allow for payment for an AT device that has been deemed necessary to achieve the goals and objectives contained in the IEP, or if teachers and/or related services professionals are told by administrators not to make assistive technology recommendations during IEP committee meetings. The second activity places state projects in the role of change agents by requiring them to develop specific systems change strategies in the area of funding. Each state project is called upon to undertake

> the development and implementation of strategies to overcome barriers regarding access to, provision of, and funding for, such devices and services, with priority for identification of barriers to funding through State education (including special education) services, vocational rehabilitation services, and medical assistance services or, as appropriate, other health and human services, and with particular emphasis on overcoming barriers for underrepresented populations and rural populations. '29 U.S.C 2212,(B)ii]

The third activity mandates that Tech Act projects involve state agencies in self-examination (i.e., in the way they collaborate to provide services to their clients).

Individuals with disabilities receive services from more that one state agency in many instances. The fourth activity addresses the need for individuals with disabilities to be self-advocates. In this regard, state projects are to engage in

> the development and implementation of strategies to empower individuals with disabilities and their family members, guardians, advocates, and authorized representatives, to successfully advocate for increased access to, funding for, and provision of, assistive technology devices and assistive technology services, and to increase the participation, choice, and control of such individuals with disabilities and their family members, guardians, advocates, and authorized representatives in the selection and procurement of assistive technology devices and assistive technology services. [29 U.S.C 2212, (B)iv]

The fifth activity focuses on working with groups that are traditionally identified as underrepresented or rural. Congress heard testimony that the existing assistive technology service delivery systems provided services for urban and suburban consumers, most of who were White. Some of the other underrepresented groups include African Americans, people whose income is below the poverty level, people who are elderly, and Native Americans.

The final activity addresses the need for there to be an efficient system of assistive technology service delivery that provides devices and services in a timely manner. Thus, state projects are to engage in

> the development and implementation of strategies to ensure the timely acquisition and delivery of assistive technology devices and assistive technology services, particularly for children, unless the State demonstrates through the progress

> reports required under section 104 that significant progress has been made in the development and implementation of a consumer-responsive comprehensive statewide program of technology-related assistance, and that other systems change and advocacy activities will increase the likelihood that the program will accomplish the purposes described in section 2(b)(1). [29 U.S.C 2212,(B)vi]

Basically, this states that state projects will provide subcontracts to protection and advocacy systems to engage in litigation activities that will have a dramatic impact on the way states deliver assistive technology services.

IDEA, in 1990, was amended to mandate that schools must consider each student's need for assistive technology devices and/or services during the IEP process (Chambers, 1997). The term "assistive technology device" and assistive technology service" were directly taken from the Technology-Related Assistance for Individuals with Disabilities Act of 1988 (PL.100-407). A student's need for AT devices and services must be considered each time that a new IEP is written according to the 1997 reauthorization of IDEA. AT devices in the past were primarily considered when a parent or staff member forced the issue at an IEP meeting. Smith (1998 as cited in Lance, 1999) points out that the new requirement is a major improvement because schools cannot determine that a student does not need AT and then never consider it again. Also, if parents of a student feel that the IEP team did not adequately consider the student's need for AT or if they disagree with the teams decision regarding AT, an independent evaluation at the school's expense can be sought by the parents (Goodman, 1996; Chambers, 1997).

According to Turnbull (as cited in Lance, 1999), Hendrick Hudson Central School District v. Rowley is a prominent court case which demonstrated the use of assistive technology to provide appropriate education. The facts are outlined in this court decision. In this case, the court ruled that because Amy Rowley was progressing from grade to grade with above average performance that she was receiving an appropriate education and did not need a full-time sign language interpreter. AT was not an issue; however, the facts of this case exemplify that AT may help students receive what is considered an appropriate education. Two assistive devices were provided in Rowleys's education, a TDD for communication between the school and her parents (who were also deaf) and a FM system for Amy's use in the classroom. The court's finding that Amy was receiving appropriate education points to the usefulness of assistive technology. Had she not used the FM system, Amy may not have made such academic and social progress and may have truly needed an interpreter. Denise Lance, an assistive technology consultant, stated the following:

> While the language of the mandate and the Rowley decision appear simple, many special educators and related service providers find great difficulty with determining the place of assistive technology within the boundaries of the Rowley standard of providing "some benefit" but not providing for maximum development, in other words, when does assistive technology move from being necessary to being just a luxury? For example, a student with cerebral palsy may receive "some benefit" from using a typewriter, but assistive technology would allow the student to complete her work in less time and with less physical effort. For further example, a student who communicates through utterances and gestures

> may be able to converse with those who know him, but an augmentative communication device increases his possible communication partners and may give him wider employment opportunities. In both cases, one could argue that AT is necessary for a truly individualized and appropriate education, while another could view the computer and communication device as exceeding the requirements of IDEA (p. 2).

In a 1992 hearing (cited in Golinker, 1994b), the issue of deeming which assistive technology device leads to appropriate education came to the forefront. In this case the school provided a Wolf AAC device to a student, Anna, with multiple disabilities and limited communication skills. This device was said to allow Anna to communicate her needs successfully to her parents but not as successfully to her teachers. Anna's parents argued that a more sophisticated device was necessary, however, if a new one was provided, it would be the Intro-Talker. Anna's parents were requesting the Liberator, a more sophisticated and expensive device. The district argued that the more costly device with more features was not appropriate or required. The hearing officer ruled that focusing merely on Anna's present abilities reflected low expectations for her progress by the school and that the Intro-Talker did not allow for enough growth in Anna's communication skills. The Hearing officer ordered the district to provide Anna with a Liberator. Also, the district was directed to include the expert called by the parents in developing Anna's new IEP, allowed Anna to take the device home, and provide Anna's parents with training in the use of the Liberator.

A case decided in April 1994, (cited in Golinker, 1994a) had a different result. A student had been provided an electronic augmentative communication device, which was

listed in his IEP. While attending another program during the summer, the device was lost or stolen. A letterboard in which to communicate was provided to the student when he returned to school in the fall. When the electronic device was not replaced, the student's parents requested a hearing to determine the appropriateness of the replacement communication device. The hearing officer decided that the school was not responsible for replacing the electronic device because they didn't lose it. Also that the letterboard was sufficient for the student to progress from grade to grade (citing Rowley), and that both the electronic augmentative communication device and the letterboard were appropriate and acceptable as fulfilling IDEA requirements.

After reviewing a line of cases dealing with the need of computers for an appropriate education, Adamson (1997) concluded that courts are likely to agree that a student is entitled to a computer when (a) the student needs it to have a basic opportunity to benefit from education; (b) it is included in a well-written IEP; (c) when it is part of a product system; (d) it would help the student remain in a less restrictive environment; or (e) the student's teacher considers the computer necessary in cases involving students' physical disabilities, but were never determined to be necessary in cases involving students with cognitive impairments. Additionally, in a few cases, the courts considered a lack of computer training for teachers of students with disabilities as a denial of related services needed for an appropriate education.

Richard W. Riley, Education Secretary, said, "Teacher education and professional development programs are not addressing the realities found in today's classrooms." This comment was made after a department survey of 3,560 teachers in kindergarten through 12$^{th}$ grade classrooms found that only one out of five teachers felt "very well

prepared" to use computers in their classroom. About the same number said they felt confident in teaching bilingual or special education children in their classrooms.... Nearly 80 percent of teachers surveyed reported having received training in technology, however, only 20 percent of those who had been through some training felt well prepared to use it in their classrooms. The survey showed that the way teachers are trained has a lot to do with how ready they feel to use what they've learned in the classroom. A significant factor in how prepared the teachers felt was the amount of time spent on their training. Teachers who participated for more than eight hours in technology training were three times more likely to say that it improved their teaching "a lot" than teachers who participated for only one to eight hours did. The survey illustrates the need to change how teachers are trained for changing classrooms. "One-shot workshops... carry little relevance to teachers' work in the classroom," Riley said. The teachers who were surveyed said they weren't ready to cope with technology as part of their curriculum, and education officials and advocates are calling for more training measures. The study showed that less than one-quarter of the teachers surveyed said they were prepared to use computers in their classrooms (eSchool News,1999).

Raskind and Higgin's study suggest that although technology has moved rapidly into the field of LD, there has been little discussion about ethical issues in regard to persons with LD utilizing technology. Due to our infatuation and fascination with technology, consequences that may have a profound effect on the lives of those with LD have not been given due consideration. Although literature exists that addresses ethics and LD, there is very little that focuses specifically on the ethical issues related to technology and LD. There are major ethical principles of beneficence, justice, and

autonomy as they relate to the ethical issues in the use of technology with individuals with LD. These three principles do not always operate in harmony. *Beneficence* refers to acting in a manner that benefits others. *Justice* pertains to treating a person according to what is fair. *Autonomy* is associated with such ideas as individual freedom and choice, and especially moral independence. Anyone examining the ethical issues surrounding the use of technology with individuals with LD should be aware of his or her own view of technology. Technology viewed from an optimistic, pessimistic or contextual perspective will influence one's response to the ethical issues and questions surrounding technology and LD (1995a). As previously mentioned, beneficence refers to acting in a way that benefits others.

> This emphasis on acting in a manner that will benefit others also appears in special education (e.g., Principles 1 and 2 of the Council for Exceptional Children's [1983] "Code of Ethics and Competencies for Teachers of Learning Disabled Children and Youth"). Historically, the primary acts aimed at benefiting persons with LD have taken the form of educational programs/interventions based on models designed to provide instruction/remediation in academic areas of deficit, such as reading, writing, and math, as well as remedial efforts aimed at improving or alleviating difficulties in specific areas of cognitive functioning, such as memory and attention. Although many of these programs/approaches have been instituted with the intention of benefiting individuals with LD, their efficacy in reaching this goal has recently been questioned by several authors (e.g., Heshusius, 1989; Poplin, 1988a; Reid & Hresko, 1981). Poplin (as cited in Raskind & Higgins, 1995a) emphasized that historical models for

remediating/alleviating LD have essentially failed. According to Poplin, even when specific skills appear to have been learned through traditional approaches, those skills do not generalize across situations or over time.

Lewis, Okolo, Barth, and Rieter's study suggest (as cited in Raskind & Higgins, 1995a) that the above controversy has a bearing on the discussion of technology and LD, because the use of technology with individuals with LD has predominantly followed the traditional mechanistic-reductionistic instructional/remedial approach. Such approaches generally take the form of computer software and include both tutorial and drill-and-practice programs (e.g., Sentence Master, New Math Blaster Plus; Lewis, 1993; Margalit, 1990). Lewis, while acknowledging that there are a number of different kinds of educational software (e.g., educational games, discovery, simulation, problem-solving, databases, desktop publishing, utilities), cited research by the U.S. Congress, Office of Technology Assessment (1988), indicating that 66% of available educational software is of the drill-and practice type, and 33% is tutorial in nature. Hresko and Parmar (1991a) also stressed that although computers and other technologies have several applications in the education of students with LD, "computer use in the schools has traditionally been limited to drill and practice" (p.46). In regard to the benefits of computers in special education, Hresko and Parmar (1991b) stated the following:

> Although much has been expected of computers in the education of the exceptional child, those expectations have not been realized. Research to date has failed to substantiate significant or even moderate gains in the academic areas. Furthermore, although some researchers have focused on the potential effects of computers on thinking and reasoning ability, research has failed to show

> significant gains. Thus the widespread hopes for educational uses of the computer remain to be realized. (p.47)

If mechanistic-reductionistic technologies are not living up to their promise of helping persons with LD, can they be considered in accord with the principle of beneficence? This is an important question, given that these forms of technology are the predominant mode of technological intervention with persons with LD. There is no definitive answer to the question. Considerable debate occurs as to the efficacy and overall benefits/value of these programs (see Lewis, 1993; Okolo et al., 1993), and for now there is no definite answer and there may be years before we have one.

Traditionally the use of technology for persons with LD has been focused on instruction/remediation, however, the greatest benefits might not be found within this area. Rather, the benefits of technology may be more fully realized through its capacity to enable persons with LD to accomplish something that could not have been done before, or reach a specific goal that otherwise would not have been possible. Assistive technology offers a means by which to circumvent weaknesses while capitalizing on strengths. For example, an individual with a reading disability yet strong receptive oral language abilities might be able to "read" through the use of an optical character recognition (OCR) system with speech synthesis. An individual having difficulty writing may be able to bypass the problem through the use of a speech recognition system that converts spoken language to computer text. The use of such technologies has the potential to increase independence, enhance self-concept, and even promote social interaction (see Raskind, 1994).

According to Raskind and Higgins, if an assistive technology (e.g., an OCR system with speech synthesis for a child with a reading disability) is introduced too early, either before an adequate number of instructional/remedial methods have been attempted or before a particular approach has had time to take effect, we are possibly robbing the individual of the opportunity to improve his or her skill deficits. This may cause the person to become technology dependent, rather than self-reliant. Furthermore, if the use of the assistive technology were to delay the implementation of instructional/remedial strategies to young children, then critical learning periods during the early years might also be lost...The use of technology with persons with LD has been primarily deficit driven. Such an approach presupposes a dysfunction that needs to be corrected, remediated, or alleviated and does little to foster special abilities or talents (1995a).

Poplin (as cited in Raskind and Higgins, 1995) also raised the issue that persons with LD may have special abilities in such areas as visual arts, music, and divergent thinking, and suggested that technology can be utilized to foster these talents. Similarly, West (as cited in Raskind and Higgins, 1995) suggested that the real benefits of technology for persons with LD lie in its potential to accentuate their distinctive abilities:

> Indeed, in some cases, these machines may come to be used as extensions and amplifiers of the imagination, permitting gifted visual-thinkers {dyslexics} to work in a visual-spatial language on fast and powerful graphics-oriented computers, developing and communicating their ideas in novel ways. (p.43)

If we are to use technology in accord with the principle of beneficence, then perhaps greater emphasis should be placed on technology's potential for fostering and nurturing special talents. We must ask whether technology promotes the social and

psychological welfare of persons with LD, or is in some ways detrimental to them (1995a).

According to Beauchamp and Walters (as cited in Raskind and Higgins, 1995) justice requires equal access to goods, services, or information to which a person has a right or is entitled. Unfortunately, persons with LD are at risk for being treated unjustly in regard to technological access and the benefits such access may bring. There are two components of technology access for individuals with LD: (a) availability of technologies and (b) operational access. In the first instance, technology access requires that the technology needed to reap the full range of benefits afforded others in the society is available to persons with LD. Operational access requires that once a technology is physically present, the individual effectively and easily operates it. Some learning disabilities themselves may hinder or restrict access to certain technologies. For example, problems with visual-motor operations may make the use of a computer keyboard or mouse difficult for a student with LD in the classroom. Memory difficulties may affect an individual's ability to carry out a series of operational commands on the keypad of a pocket-sized electronic personal data manager. Organizational difficulties may cause problems in utilizing the menu system of an on-line electronic database. Reading difficulties may inhibit access to the "help" and "tutorial" portions of education and business software programs.

The quality of life for individuals with LD can significantly be diminished if there are specific problems in operationally accessing particular technologies. Difficulties in the ability to utilize education technology could restrict equal access to education. To ensure the accessibility of specific technologies, developers must develop devices with

individuals with LD in mind. In order for this to take place, manufacturers/developers must directly involve individuals with LD and LD professionals in the development process. Several manufacturers have made an effort to solicit input from end-users with LD, however they are few in number and an increasing number of technology manufacturers while involving persons with disabilities, they tend to be from groups other than the LD population (Raskind, 1993).

Another question arises: Who is ultimately responsible for ensuring that technologies are operationally accessible to persons with LD? Also, who is ultimately responsible for bearing the costs of making specific technologies accessible? Is it the individual, the manufacturers, the government, the education system, or society as a whole? Legislation (i.e., ADA, Individuals with Disabilities Education Act of 1990 [IDEA], Rehabilitation Act of 1973, Technology-Related Assistance for Individuals with Disabilities Act of 1988) has attempted to provide some initial mechanisms of distributing the financial burden across the educational system, the government, manufacturers, and employers (depending on the situation). Although a society with increasingly technology-based goods, services, and information has the potential to promote justice for persons with LD, without due reflection and thought, even more barriers may be created. The potential for receiving outdated technology is further complicated by rapid advancements in technology, which often are not modified/adapted until after they have been introduced to the general public (if at all), once again leaving persons with disabilities behind. Would a just system of technology access provide the LD population with yesterday's technology? (1995a)

According to Raskind and Higgins, the principle of autonomy, as previously discussed, is associated with such concepts as freedom from external control, opportunities for choice, voluntariness, pursuit of interests, and self-mastery. Similar concepts are also appearing in LD literature on holism/constructivism (e.g. Heshusius, 1991; Poplin, 1988b). Proponents of the holistic/constructivist teaching/learning process maintain that children with LD should pursue learning experiences in which they are passionately interested and that have relevance to their own lives. Also, they need the opportunity to self-regulate their learning and be active in their own learning. (Raskind, 1995) Such notions appear to be in contrast to the mechanistic-reductionist beliefs of traditional approaches to LD. In discussing this difference, Heshusius stated the following:

> Once the meanings of self-organization, self-regulation, and dynamic interaction are grasped, it becomes clear that externally controlled, programmed ordering of progress contradicts these crucial holistic principles (indeed contradicts natural learning) and can, in fact, thwart authentic progress... Meaningful progress can be fostered, but not forced or programmatically controlled. (p.452)

Maddux and Russell's study (as cited in Raskind and Higgins, 1995) suggest that the majority of instructional technology used with children (and adults) with LD tends to be highly programmatic, sequential, and tightly controlled; thus leaving little room for the individual to pursue learning experiences that are self-directed, self-regulated, or of passionate interest to their lives. Furthermore, these technologies promote passive interaction and offer the learner little control over what takes place in the program. The ethics of using such technologies in the teaching/learning process comes into question, as

they may tend to restrict choice, impose external control, and limit pursuit of interests. Perhaps more open-ended and learner-centered technologies would allow for greater freedom, self-direction, and pursuit of personal interests. These types of educational technologies would help ensure that we do not limit the autonomy of individuals with LD. We must be careful not to be influenced by enticing offers by manufacturers, attractive packaging, fancy graphics, and engaging sounds when selecting specific technologies. The selections must be based on sound educational principles and research.

Lewis' study suggest that such widespread use of technology is a relatively recent phenomenon, and one indication of this is the availability of computers for classroom use. In the early 1980s, less than half of U.S. public schools owned a computer (Quality Education Data, 1985). By the late 1980s, almost every school owned at least 1 (Office of Technology Assessment, 1988), and by the early 1990s, the number of computers had risen to 2.5 million, or approximately 1 computer for every 19 students (Market Data Retrieval, cited in Kinnaman, 1992). At present, there is general agreement that computers and other technologies have great potential for enhancing the capabilities of children, youth, and adults with learning disabilities (Alliance for Technology Access, 1994; Lewis, 1993; Lindsey, 1993; Male, 1994).

> According to Lewis (cited in Lewis, 1998), assistive technology has two major purposes. First, it can augment an individual's strengths so that his or her abilities counterbalance the effects of any disabilities. Second, technology can provide an alternate mode of performing a task so that disabilities are compensated for or bypassed entirely. For instance, individuals with difficulties in reading may be able to capitalize by listening to books on tape, rather than reading the print

> versions. Persons with poor computational skills might use a handheld calculator; those with poor spelling might write with a word processor that offers spelling assistance. (p. 17)

Cavalier, Ferretti, and Okolo (1994) suggested a similar distinction. They noted that technology can act as a cognitive prosthesis, replacing an ability that is missing or impaired, or as a cognitive scaffold, providing the support needed to accomplish a task. Disabilities can impose barriers to full participation in school, at work, and in other important areas of life. Assistive technology offers ways to surmount those barriers. As the following sections explain, one way to think about the many technologies that are currently available is in relation to the type of barrier each addresses.

**Print Barriers**

For persons with vision impairments and others who have difficulty reading, print materials are obstacles. Preschool children, beginning readers, and individuals with learning disabilities who have not yet mastered the skill of reading would be included in this group. The most common way to overcome print barriers is to present the information through a sense other than vision. Blind individuals might use the sense of touch to read Braille, or might listen to information rather that read it. There are other options for individuals with LD and others who may not be competent readers. Auditory displays of information are often more accessible that print displays. Other options would include taped books, devices that read print books aloud, and "talking" computer programs (Lewis, 1998).

**Communication Barriers**

According to Newcomer & Barebaum (as cited in Lewis, 1998) individuals with speech and language disorders experience oral communication difficulties. Many persons with LD along with beginning writers experience a similar difficulty with written communication. Poor handwriting, spelling, organizational skills, productivity, and quality of writing are common written communication problems related to learning disabilities. Instructional intervention is the most typical response to these problems. AT supports individuals with LD by providing strategies to bypass or compensate for specific problem areas. Most technological approaches to writing are computer based; examples are word processing programs, spelling and grammar aids for editing assistance, and programs to help writers organize their thoughts in the planning stage of the writing process.

**Learning Barriers**

Learning disabilities interfere with the learning process by inhibiting the acquisition of new skills and knowledge and the recall of previously learned material. The most typical response to problems in learning, as with communication barriers, is instruction. Assistive technology enhances the range of instructional options available to teachers, or to adults with learning disabilities who are directing their own learning. Technology provides a wealth of alternatives to supplement or take the place of traditional approaches, such as lectures and textbook readings (Lewis, 1998). For example, learners can gain new information by listening to audiotapes, audio CDs, and radio; watching films, videos, and television; participating in instructional activities delivered by computer and videodisc; and interacting with electronic information sources.

such as CD-ROM-based reference "books" and the date-bases found on the Internet. One of the most popular technological alternative is computer-based instruction: well-designed computer programs offer learners carefully sequenced, individualized activities and frequent, informative feedback on the quality of their responses. Such programs have the potential to increase the quantity, and in some cases the quality, of instruction.

As more students with LD in general and special education settings are identified as needing assistive technology devices and services, teacher preparation programs will have to address training issues, however, the use of AT should not be expected to produce miracles. Deborah Baker works as a special education teacher in a sixth-grade blended program at Wayloan-Cohocton Middle School in Wayland, New York. She suggests that the benefit of using technology to supplement and extend the learning process are many and varied. Additionally, she explains, it's not that the students all produce "absolutely wonderful pieces of work. That's what I expected at first, but in all honesty, it's not always what happens. The technology is most helpful as a stimulus. It motivates them to solve problems and make decisions in ways that would not have been possible in a regular classroom."

At Wayland-Cohocton, technology and inclusion provide an important opportunity for social interaction. When working on a multimedia Hyperstudio project, regular students and disabled students sit side by side at the computers. Baker notes that they sometimes figure out how the software works or how to program a button before the regular education students sitting next to them. These successes boost their self-confidence, as does access to tools such as spelling checkers, grammar checkers, and thesauruses that students are typically reluctant to use in printed form. For students with

disabilities the best thing about technology, says Baker, is that it equalizes the playing field. "It can help them so that they are not constantly reminded of their disabilities. They can be like all the other kids." In many instances, success depends upon choosing the right technology (Holzberg, 1998).

Terry Lankutis stated that many learning disabled children are unable to produce quality written work, "Either they can't spell very well or they have difficulty taking the thoughts in their head and getting them down on paper. The writing process is often very frustrating for them." (Holzberg, 1998) She believes that educators frequently underestimate their special needs students. In the long run, it costs much less to offer all this technlogy-assisted instruction, suggests Sharon Keller, Colonial School District technology coordinator and special education teacher in New Castle, Delaware, "If you don't provide a free and appropriate education as regulations require, parents can sue the school district for not meeting a student's needs. Inevitably, legal proceedings are far more costly than buying the student equipment. And, if a student meets with success, graduates from high school, and turns out to be employable, then they won't be on the welfare rolls." One of the best things about using technology to instruct students with special needs is seeing the looks on their faces when they realize they can do something they had previously been unable to do, says Keller. The technology also raises teacher expectations. "When teachers have higher expectations, children tend to achieve more." (Holzberg, 1998). Training individuals with disabilities in the use of AT devices and services is a current trend in the fields of special education, rehabilitation, and technology. The use of devices compensate for their disabilities and/or utilize their functional abilities to meet environmental demands. The Tech Act mandates accessibility

and accommodations for individuals with disabilities to promote integration and full participation in society.

Faculty members, in higher education, responsible for designing teacher preparation programs must explore ways to structure curricula, methodologies and practica into teacher preparation programs in LD....Because of inclusive settings general educators as well as special education teachers will have to demonstrate competencies with various devices (Bateman, 1994).

## Discussion

A learning disability is a permanent condition in which an individual with otherwise good overall ability has difficulty in learning and using certain kinds of information, or in learning in particular ways. While the cause may not be known, it is not low intelligence, emotional disorders, poor teaching, lack of educational opportunity, or sensory loss. Some physical or behavioral characteristics may or may not accompany and complicate the learning disability, such as hyperactivity, distractibility, poor coordination, impulsiveness, and others, but these are not the cause. You don't outgrow learning disabilities, children who have learning disabilities are going to become adults with learning disabilities and the future of assistive technology holds much promise, however, it is uncertain. According to the "Journal of Learning Disabilities," (as cited in Flynn, 1996)

> approximately 10% to 15% of employees in any large industry or business have learning disabilities. The Americans with Disabilities Act has required employers to make reasonable accommodations for the need of employees with physical or mental disabilities since 1994. Disabilities can include anatomical losses, impairment of one or more sense, learning disabilities and emotional illness. The law fails to precisely define reasonable accommodation but offers some examples, and ignoring the rules could get a company in major trouble. Most people with learning disabilities look just like everyone else. A learning disability can come in the form of dyslexia, which makes reading difficult and can affect people of even genius-level intelligence (such as Albert Einstein and Thomas Edison). Or it may be more severe, such as disabilities that cause a person to be lower-

> functioning—though not to the level of low intelligence or retardation. "It's very difficult to identify people with learning disabilities," says Elaine Reisman, assistant professor at Lesley College in Cambridge, Massachusetts, and director of the Threshold Program, a center to aid people with learning disabilities. "People in business can be very aware if someone needs a wheelchair. But if someone is a slow learner because of a learning disability, it's not apparent right away, and you don't know right away what to do about it." (Flynn, 1996) Computers give individuals the opportunity to learn at their own pace. (p. 78)

For this reason it is imperative that there is professional development in the area of assistive technology and teaching, also, it is imperative that the field of special education and others concerned with the welfare of individuals with learning disabilities continue to act as strong advocates for equitable distribution of technology resources.

Too often we lose the contribution of LD students, who may have ideas and knowledge worth communicating, but who face frustration and defeat when they attempt to put their ideas in writing. Making students with learning disabilities dependent upon the computer has never been seen as an appropriate educational objective. Instead, the emphasis of our efforts should be on exploring ways that the computer can be used to enhance these students' strengths, minimize their deficiencies, an enable their success within the existing classroom curriculum. In addition, teachers need the time and opportunity to learn what the technology can do, how to operate it, and when and how to implement and integrate it into their teaching.

Innovative learning tools open information pathways and challenge the imaginations of students with disabilities. The proper use of technology in the classroom

has allowed disabled students to participate effectively in the learning process. Added to these benefits for students with disabilities is the knowledge that all students, disabled and non-disabled alike, are positively affected. But for disabled students in particular, technology makes things possible. Additionally, much of the software developed for mainstream classrooms can be successfully adapted to the student with special needs.

Latham (1997) states that

> teachers should consider all the variables before adopting a technological innovation, just as they would with any new teaching strategy. Among these variables are the technology's flexibility, how soon it may be out of date, and, indeed, whether it is needed at all. As Howell (1996) warns, in our rush to obtain increasingly sophisticated equipment, we may fail to take full advantage of existing tools.
>
> This brings us to the importance of training teachers to reap the full benefits of existing technology. No matter how sophisticated the equipment, it is virtually useless without thoughtful implementation by knowledgeable practitioners. (p. 88)

According to Guskey ( as cited in Kimmel, 1999) Professional development and in-service training for teachers have become key components for reform in teaching and curriculum change. It has become accepted that long-term intensive professional development programs are necessary and that short inservice programs or workshops are not sufficient to produce sustained change. (p.1)

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